LATE PERMIAN AND TRIASSIC TERRESTRIAL TETRAPODS OF NORTH CHINA

by

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Abstract

In the past, tetrapods from the terrestrial Permian and Triassic sediments of North China have been either very rare or totally absent, with the exception of the *Sinokannemeyeria* fauna from the Upper Ermaying Fm. Within recent years, the collection of material to fill the vacancies has increased sufficiently to allow a comprehensive synopsis of China's representative ages and faunal complexion. This text is an introduction to the four Late Permian to Early and Middle Triassic bone bearing horizons, which in ascending order are the upper section of the Shihchienfeng Fm. and the Shihhotze Fm., the Heshangou Fm., the basal section of the Ermaying Fm., and the upper section of the Ermaying Fm. Preliminary analysis is conducted on the taxa from each stratigraphic level. Correlation of North China faunas is made to those in China's Xinjiang Autonomous Region and other globally related terrestrial faunas.

I Introduction

The study of Triassic terrestrial tetrapods (reptilia and amphibia) has increased in global significance, as this research not only confirms the existence of the Laurasian supercontinent, but moreover increasingly suggests that there was faunal exchange between it and the Gondwana supercontinent. Att that time, both existed as floating land masses. Research regarding Triassic tetrapods and the correlations of their ages and faunas is therefore extremely significant. China's Early and Middle Triassic (as well as Late Permian) terrestrial tetrapods are predominantly distributed in two vicinities: the Xinjiang Autonomous Region and the North China Region. The latter encompasses such districts as Shanxi, Shaanxi, and Henan provinces, Inner Mongolia, and the central reaches of the Yellow River. Recently, Middle Triassic tetrapods have also been discovered in the Badong Fm. of Hunan Province. The Permian and Triassic vertebrates from the Xinjiang Autonomous region have been previously published with preliminary faunal divisions and correlations (Sun, 1973). Recently, a new taxon has been discovered from Sangzhi, Hunan, in South China, but it is still too insufficient to elaborate upon faunal attributes. Therefore, emphasis will be placed on preliminary discussions regarding the age and faunal character from each of the stratigraphic positions in North China.

II Synopsis of research

The first record of a Chinese Triassic tetrapod was made by C.C. Young as early as 1937, this being *Sinokannemeyeria pearsoni.* Subsequently, work was halted for twenty years. It was not until after the establishment of the People's Republic, in the years 1955-56, that the Institute of Vertebrate Paleontology, and Paleoantrhopology, Academia Sinica (IVPP) (at that time under the designation of "Laboratory of Vertebrate Paleontology") organized a field team in order to renew investigations where *Sinokannemeyeria* was discovered. The result was an ideal assemblage of vertebrates. This material was studied and published upon in the 1960s and subsequently designated the *Sinokannemeyeria* fauna. In 1959, with the convening of the National Geological Congress, the section of rocks containing *Sinokannemeyeria* was differentiated from the Yanchang Series and Shihchienfeng Series, and individually established as the Ermaying Series, with its age determined as encompassing the late Early Triassic to the early Middle Triassic. At that time, this fauna was regarded as being correlative to the South African "*Cynognathus* Zone."

In October, l958, the Erduoci Petroleum Survey Team discovered two mandible fragments at Linzheyu, Baode Co., Shanxi Province. Its locality suggests that the material should have been collected from the lower section of the Ermaying series. One of the specimens consists of a piece of maxilla with three acrodont teeth later diagnosed as being the procolophonid *Paodeodon*; the other specimen is the Cynodont, *Ordosiodon*. Aroused by these implications, IVPP dispatched personel to Shanxi anticipating the collection of new material from this previously unknown stratigraphic position. Furthermore, there were almost no collections from the lower section of the

Ermaying and the underlying Heshankou formation. As a result of these efforts two additional incomplete pareiasaur skulls were recovered from the even lower sediments referred to as the Sunjiagou deposits (in the restricted sense currently assigned to the Shihchienfeng Fm.). This vertebrate, designated *Shihchienfengia*, represents the oldest Permian reptile from the North China region. Three years later, IVPP sent another field party to Jiyuan Co. in Henan Province, where the Theriodont, *Traversodontoides* (Young, 1974) was found in the Upper Ermaying Fm. In addition, at Gedaling, Dayuhuai, in this same County, several vertebrates were found in the Upper Shihhotze Fm. predominantly represented by fragmentary teeth. Among them were several teeth belonging to pareiasaurs, and possibly several teeth belonging to amphibians and dinocephalians. This locality was reexcavated in 1972, but aside from fragmentary material no relatively good specimens were recovered.

Since the 1960s colleagues from the Institute of Geology have made a collection of Triassic vertebrates from Inner Mongolia and northern Shanxi. In addition to collections made from the Upper Ermaying, a complete kannemeyeriad skull was excavated with several other specimens from the Lower Ermaying deposits. Several comparatively good specimens were also collected for the first time from the Hoshankou Fm., among which were a primitive thecodont skull, a ceratodont jaw, and several labyrinthodont amphibians. These fossils, at the very least, are evidence that the age of the Hoshankou Fm. is not Permian but Triassic.

The Xinjiang Autonomous Region in western China produces a perfectly good *Lystrosaurus* fauna. Why then does this type of fauna not exist in North China? Moreover, what is the nature of the animal assemblage underlying the Upper Ermaying *Sinokannemeyeria* fauna? These are certainly topics for future research.

In the years 1976 to 1977, the IVPP organized a small team to advance research and make collections at the border regions of Inner Mongolia, Shanxi, and Shaanxi provinces, from which a relatively ideal collection was made. The study of this material has yet to be sufficiently completed and the work has only just begun. However, data is now present from sediments of both the Lower Ermaying and Heshankou that provide preliminary introductions to the faunas. These data suggest preliminary conclusions regarding their respective ages and correlations.

III Faunal composition

Presently, Permian and Triassic terrestrial tetrapods are contained in four stratigraphic horizons which, briefly summarized in descending order, are as follows:

Upper Ermaying *Kannemeyeria* Fauna: Large Dicynodonts are the predominant taxa, consisting of the three genera *Kannemeyeria, Parakannemeyeria,* and *Shansiodon*. The former two are large individuals while the latter is small. Material representing the primitive thecodont *Shansisuchus* is also abundant, as exemplified by massive fossiliferous block with the vast majority of elements belonging to this genus. Other thecodont taxa include *Fenhosuchus* and *Wangisuchus*. The cynodonts are represented by *Sinognathus* and *Traversodontoides*, of which there is only one specimen representing each individual. The Procolophonia is also represented, but only by the single skull of *Neoprocolophon.* In addition to the Reptilia, there are a certain amount of capitosaur vertebrae and armor plates. However, as the material is fragmentary, a more accurate diagnosis is currently not possible.

The Lower Ermaying: More precisely speaking, this is the base of the stratigraphic section, and the source of much material collected recently. In the past, *Paodeodon* and *Ordosiodon* were recorded. A colleague by the name of Keyuan Di recently discovered a kannemeyeriid skull that, after being studied by Zhengwu Cheng, was erected as the new genus *Shanbeikannemeyeria*. Fragments of *Parakennemeyeria* have also been found. At this locality, although the ratio of kannemeyeriid dicynodonts are dominant, scaloposaurs which were

previously unknown from these sediments, are present. Prepared specimens also include a partial skeleton of a thecodont as well as a procolophonid skull.

The Hoshankou Fm.: Until just recently, this formation was considered unfossiliferous. However, work in recent years has confirmed this formation to be an extremely productive fossil lithology. Within these deposits, aside from the thecodonts already mentioned, are many individual skeletons of procolophonids, which from the perspective of their skull morphology, may belong to the same genus, and are more primitive compared to the Upper Ermaying *Neoprocolophon.* One very interesting specimen is an excellent scalaposaur skull recovered from the Hoshankou that compares precisely to the specimen from the Lower Ermaying. Amphibia are also represented.

Permo-Triassic: The lowest stratigraphic position is represented by the Shihchienfeng Fm. and the top section of the Upper Shihhotze system. The stratigraphic relationship between these two formations is still not very clear, but from the perspective of the faunas, it is evident that these sediments share the same faunal characteristics. Here pareiasaur material is abundant; however, with the exception of *Shihtienfenia*, there have been no other genera reported. This is a relatively complex issue, because according to C.C.Young, in addition to the Pareiasauria, the reptile fauna contains such taxa as Dinocephalia, Cynodontia, Gorgonopsia, and a seymouriamorph amphibian, all of which may possibly exist here, but are only represented by such material as fragmentary teeth. Hence, this paper does not recognize these latter forms. Table I displays the faunal complexes with their repective stratigraphic positions.

Table I. Faunal list of Permo-Triassic tetrapods in the North China Region.

	Upper Ermaying (*Sinokannemeyeria* Fauna)	Lower Ermaying	Hoshankou	Shihchienfeng Upper Shihhotze
Labyrintrodontia	Capitosauridae		Captiosauridae Benthosuchidae	Seymouriamorpha
Procolophonia	*Neoprocolophon*	Baodeodon	Procolophonidae Gen.	
Cynodontia	*Sinognathus Traversodontoides*	*Ordosiodon*		Procynosuchidae
Dicynodontia	*Sinokannemeyeria Parakannemeyeria Shansiodon*	*Shanbeikan-nemeyeria Parakannemeyeria*		
Thecodontia	*Shansisuchus Fenhosuchus Wangisuchus*	Proterosuchia Gen.	*Fugusuchus*	
Scaloposauria		*Ordosia* Scaloposauria Gen.	Scaloposauria Gen.	
Pareiasauria				*Shihtienfenia*
Dinocephalia				Tapinocephalidae

IV Discussion of faunal characteristics with remarks upon their ages and correlations

1. *Sinokannemeyeria* Fauna: As early as twenty years ago, the National Stratigraphic Congress established the age of the Ermaying system as extending from the late Early Triassic to the early Middle Triassic, based, at that time, on the correlation of this fauna to the South African *Cynognathus* Zone, which is generally regarded as late Early Triassic. However, consideration of the overlying conformable Yanchang Flora causes geologists to believe the age of the Ermaying includes a portion of the Middle Triassic.

Following the accumulation of related material both within and outside of China within the past twenty years, it is possible to correlate the stratigraphic position of the *Sinokannemeyeria* Fauna more accurately. In India, Jain et al. (l964) reported the discovery of a new bone bed in the Gondwana deposits, designating it Yerapalli. Contained within these rocks are such taxa as kannemeyeriids, small gomphodonts, *Erythrosuchus*, and many labyrinthodonts. At that time, the workers correlated it to the South African *Cynognathus* Zone but believed its age may have been slightly younger, possibly extending into the early Middle Triassic. Subsequently, at the Second Gondwana Symposium, Kutty and Roy-Chowdhury suggested that the age of Yerrapalli should be younger than Early Triassic or equivalent to the Manda deposits of Tansania, based upon the correlation of the large dicynodont, *Richnisaurus*, and the South American *Dinodontosaurus*. The upper section of the former Soviet Union's "Zone VI" is equivalent to the Middle Triassic Upper Dongus deposits (Dongus II). Originally, the predominant elements produced here were amphibians, but most recently several large dicynodonts have been discovered as well as procolophonids and thecodonts. This fauna was designated the "Labyrinthodont-Dicynodont Complex." Most recently, this complex has also produced fragmentary material of gomphodont cynodonts.

In the southern continents, with the exception of South and East Africa, new depositional systems spanning the Early to Middle Triassic have been recognized. In South America large dicynodonts exist throughout these deposits. Keyser (1973) reported a new stratigraphic level in West Africa, called the Etjo Beds, that contain three genera of large dicynodonts. For these reasons it is quite evident that dicynodont correlations may be applied with relative effectiveness. The large dicynodonts (including the families Kannameyeriidae and Stahleckeriidae) are recovered from each of the Early, Middle, and Late Triassic Stages. Moreover, these taxa differ in each of the stages, with the individuals in the later stage exceptionally derived. Those taxa found in North and South America exhibit reduced tusks, are etentulous, and lose the suture between the post orbital and squamosal. Currently, it appears that the two kannemeyeriid genera from the Upper Ermaying deposits, although very similar, are not congeneric with *Kannemeyeria* from South Africa. The genera from India or the Soviet Union, such as *Rechnisaurus* and *Uralokannemeyeria* also differ greatly. These taxa all have a comparatively shorter parietal crest, with a short temporal fenestra. Furthermore, both have extremely well developed tusks and canines. A morphological comparison of the Late Triassic genera suggest the Early and Middle Triassic dicynodonts are not derived, but maintain several mosaic characters. Worth notation is the fact that dicynodonts similar to *Kannemeyeria* from the South African *Cynognathus* Zone exist in China, but they are recovered from a different stratigraphic level, this being the Lower Ermaying, which will be discussed later in the text.

The gomphodonts are another taxa to be considered. This name is not a valid taxonomic term, but one that represents cynodonts that possess a transversely broadened dentition. Generally speaking, it includes the Traversodontoidea and Diademodontidae. India and the Soviet Union preserve gomphodont cynodonts, but the material is rare. Two Cynodonts have been recovered from the Upper Ermaying deposits, one diagnosed as *Sinognathus* (Young, l959), and one diagnosed as *Traversodontoides* (Young, l974). The latter, at the time of its description, was suggested as belonging to the gomphodont family Traversodontoidea.* Members of this family are predominantly found in the Middle Triassic of South America. *Sinognathus* belongs to the family Cynognathidae and is regarded as similar to *Cynognathus* from the *Cynognathus* Zone of South Africa. However, *Cynognathus* is a relatively large individual with a skull that closely resembles a dog and displays long and narrow post canine teeth. *Sinognathus* is clearly dissimilar, and from its outline more closely resembles *Traversodon* or *Belesodon*. Because this specimen's mandible

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* This text's author has reassigned this specimen to the Bauriidae.

and maxilla are tightly occluded, and there appears to be no method of separating them, the precise nature of the dentition is obscured. However, there are indications (from observing the lingual and labial sides of the teeth) that this specimen may very possibly be a gomphodont cynodont. If this is accurate, then there are no narrow toothed cynodonts represented in the *Kannameyeria* Fauna of China. The stratigraphic position of the fauna, from the perspective of the gomphodont cynodonts, extends from the Early to the Middle Triassic. However, the predominant elements in the entire *Sinokannemeyeria* Fauna are the large dicynodonts and not gomphodonts or rynchosaurs. Therefore, sufficient evidence is lacking to confirm the age of the Ermaying Fm. as late Middle Triassic, and instead it may be correlated to the supposedly equivalent Indian Yerrapalli and Soviet Union's Dongus System. The *Kannemeyeria*-bearing Kelamayi Fm. in Xinjiang may also be appropriately correlated to this fauna.

2. Lower Ermaying Fauna: This assemblage consists predominantly of the aforementioned large dicynodonts. *Parakannemeyeria* has been formally asserted to be found at the top of the section, and is coexistent with the new genus *Shanbeikannemeyeria.* This new genus is characterized by an extremely long, narrow, and highly projected parietal crest, a relatively short preorbital section, an extremely conspicuous anteroposterior obliquely inclined occipital region, and tusks not as well developed as either *Sinokannemeyeria* or *Parakannemeyeria*. Due to these characters, it is generally acknowledged that this taxon is more similar to the previously mentioned genus *Kannameyeria*. The cynodont *Ordosiodon* is represented by an incomplete jaw that is nearly edentulous. Consequently, it is extremely difficult to make a more precise taxonomic assignment. According to C.C. Young, it belongs to the herbiverous Diademodontidae, the gomphodont represented from the *Cynognathus* Zone of South Africa.

The discovery of the Scoloposaria was a fortuitous find for paleontologists in China. At the time of the discovery, three individuals were recovered, one from the Hoshanko Fm. and two from the base of the Ermaying. The skull of one of those from the Ermaying is identical to that from the Heshankou, creating the possiblity of a correlation to several taxa from the "*Lystrosaurus* Zone" of South Africa, which will be discussed later in the text. Another individual clearly represents a different taxon. A recently discovered skull of a procolophonid is a moderate sized individual, and judging from the square structure of the jugal, is advanced, possibly lying between *Neoprocolophon* and the new form recently discovered in the Hoshankou Fm. Currently, it is not possible to provide a reliable taxonomic assignment although it appears to bear no relationship to *Paodeodon*. Several thecodonts have been recovered from thelower Ermaying that belong neither to *Shansisuchus* , nor to the same genera found in the *Sinokannemeyeria* fauna. Among the specimens are fragmentary material that consists of highly specialized cervical and dorsal vertebrae. Additionally, there are fragments of femur and limb bones that may belong to the Protorosauria. Furthermore, there are several small thecodonts that have distinct intercentra on the dorsal vertebral column. Some of these specimens maintain armor above the neural arches and may possibly represent a primitive ornithosucid. Therefore, currently, with the exception of *Parakannemeyeria*, there are no taxa congeneric with the *Sinokannemeyeria* fauna, or to the degree of differing at a higher rank of classification. Obviously, the material is too limited to compare it to another fauna. Therefore, it may only be minimally stated that, at the present time, the fossil data from this stratigraphic position cannot belong to the *Sinokannemeyeria* fauna.

A stratigraphic horizon in the Xinjiang Autonomous Region that may correlate to the Lower Ermaying still has not been discovered. The unfossiliferous Shaofangou Fm. conformably underlyies the Kelamayi Fm., which produces a *Kannemeyeria* Fauna. Therefore, stratigraphically speaking, the top of the Shaofangou Fm. may be equivalent to the basal section of the Ermaying. The age of the Shaofangou may be late Middle Triassic, which may then be correlated to the South African *Cynognathus* Zone, or it may possibly be slightly older as it is stratigraphically slightly lower.

3. Heshankou Fm. : Early Triassic tetrapods in North China are represented in this lithologic unit. According to the current material, dicynodonts are genuinely absent from these rocks, although relatively abundant procolophonid material exists. These procolophonids are relatively small morphologically consistent individuals that differ from *Neoprocolophon.* Material consists both of a well-exposed palates and post-cranial skeletons. Procolophonids constitute a large proportion of the material collected. It was mentioned previously that a scoloposaur skull resembling those from the Lower Ermaying Fm. had been discovered. This specimen is similar to the Ericiolacertidae and Scaloposauridae based upon characters such as the morphology of the secondary palate, the unconnected postorbital bar, and the increased breadth of the post canine teeth. The scoloposaurs are principally found in South Africa, such that with this specimen it is possible to make a correlation to *Ericiolacerta* and *Regisaurus* contained in the South African *Lystrosaurus* Zone, although it is possible that the Heshankou specimen is a little more derived. The Bauriamorphs *Bauria, Sesamodon*, and *Watsonella* from the South African *Cynognathus* Zone are particularly derived with such diagnostic characters as reduced caniniform teeth and enlarged incisoform teeth. These features are unobservable on the Chinese specimens.

The stratigraphic position of *Urumchia* from Xinjiang has not been sufficiently established. At the time of its earliest description, C.C. Young assigned its age to the Late Permian due to its assignment to the Therocephalia. In 1963, a colleague from a Xinjiang research team inspected the original locality and reconsidered the stratigraphic range of the Chiutsaiyuanzi Fm. in this region's sequence. This subsequently caused *Urumchia* to become a member of the *Lystrosaurus* Fauna. Additionally, C.R. Mendrez later corresponded with C.C. Young suggesting the possible affinity of *Urumchia* to *Regisaurus.* She further suggested that the specimen's upper and lower jaws be separaeted, which was later accomplished and caused C.C. Young to reevaluate the specimen and publish another manuscript. The current author agrees with the observations of Mendrez, believing it to be similar to *Regisaurus* from South Africa. The Chinese specimen should then correlate stratigraphically to the late Early Triassic *Lystrosaurus* Beds.

There are currently two thecodont specimens, one, *Fugusuchus*, has been formally studied by Jengwu Cheng and is believed to possess characters that lie between *Chasmatosaurus* and *Erythrosuchus.* A second specimen, collected by IVPP may be an armored pseudosuchian. According to Jengwu Cheng, some amphibian material has also been discovered, which include both the Capitosauria and Benthosuchidae. There is absolutely no doubt that the age of the Heshankou Fm. is Triassic based upon the vertebrate fossils contained within it. The several families produced here are all fundamentally Triassic and not Permian, with the exception of one individual which is a primitive Late Permian representative. That these animals belong to the Triassic is not the question: the problem is whether or not this formation is as old as the *Lystrosaurus* Zone, or the early Early Triassic.

Worldwide, Early Triassic faunas consist of two models. One is referred to by E.H. Colbert as the "Labyrinthodont-*Chilotherium* Complex." This complex consists either solely of labyrinthodont amphibians or consists of these amphibians coexisting with the footprints of *Chilotherium*, and lacking any other very small reptiles. This condition exists from Greenland to Spitzbergen to North America, and straight through to Madagascar. The second model also contains amphibians but with a certain amount of reptiles. This condition exists in South Africa, India, the former Soviet Union, Australia, and China where amphibian populations may exceed the reptiles or the reptile populations may exceed the amphibians. Because amphibians from China are extremely rare, China belongs to the latter scenario. With the exception of Australia, regions belonging to the second model produce the Early Triassic *Lystrosaurus* fauna. This fauna is a standard assemblage for the beginning of the Triassic and is distributed nearly globally. Aside from the records already known from South Africa, India, and Xinjiang, China, occurrences of this fauna were reported in 1970 from Antarctica, and most recently the former Soviet Union. Not only are the *Lystrosaurus* genera the same in these regions, but moreoverthey are conspecific.

Additionally, coexisting *Chasmatosaurus* also has the same degree of extensive distribution. Currently, neither *Lystrosaurus* or *Chasmatosaurus* have been discovered in the North China Heshankou Fm., nor has *Prolacertoides* been discovered. Therefore, based upon the current data, it is impossible to accurately correlate the Chiutsaiyuantze Fm. of Xinjiang to North China sediments.

A condition in South Africa is worthy of notation. Originally, the Early Triassic was separated into three associated fossils zones: The upper *Cynognathus* Zone, the middle Procolophonid Zone, and the lower *Lystrosaurus* Zone. Later, the Procolophonid Zone was considered to be a faunal discrepancy and was abandoned, as J.W. Kitching discovered the co-occurrence of procolophonids and lystrosaurids at a good number of localities which caused him to combine the Procolophonid Zone with the *Lystrosaurus* Zone. The question exists, then, whether it is feasible that this same faunal discrepancy exists between the *Lystrosaurus* stratigraphic position in western China and the Heshankou Fm. in North China which which lacks *Lystrosaurus* but produces relatively abundant procolophonids. Or, it may be that these faunal duscrepancies are a result of disconnected paleoenvironments. One cannot discount these possibilities.

Based upon character analysis on each of the aforementioned taxa, it is believed that the stratigraphic position of the Heshangkou Fm. may possibly be slightly higher than the western China *Lystrosaurus* beds for the following reasons: (a) *Fugusuchus* is not as primitive as *Chasmatosaurus*, (b) the Scaloposauria are more derived than the species found in the *Lystrosaurus* Zone of South Africa, and (c) there are several thecodonts that may possibly belong to the Ornithosuchidae. However, it is relatively certain that the Heshangkou Fm. is older than the South African *Cynognathus* Zone as the thecodonts and the Scaloposauria coexistent with *Fugusuchus* are not as derived as those represented in the *Cynognathus* Zone. Therefore, it may also be appropriate to place the Hoshankou Fm. between the *Lystrosaurus* and the *Cynognathus* zones. Obviously, the age correlation of these rocks is quite complex.

4. Shihchienfeng and Upper Shihhotze formations: There is no question that the age of the taxa from these sediments is Late Permian. The Pareiasauria are found both in South Africa and the former Soviet Union, but their faunal proportion is smaller in the former than in the latter. This is due to the South African Permian fauna consisting predominantly of dicynodonts, which by A.S. Romer's estimation, may constitute four fifths of the assemblage. Although the quantity of pareiasaurs is small, they are stratigraphically distributed from the South African late Middle Permian *Tapinocephalus* Zone continuously through to the late Late Permian *Daptocephalus* Zone. Wetlunga Zone IV of the former Soviet Union has been designated the *Pareiasaurus* Complex and assigned to the Upper Tatarian stage of the late Late Permian. However, pareiasaurs also exist in the Upper Kazanian stage of the late Middle Permian. An additional family of reptiles, the Tapinocephalia, is recovered from India, the former Soviet Union, and North China. In China they are still only represented by isolated teeth. In South Africa the Tapinocephalia constitute the predominant taxa from the *Tapinocephalus* Zone. In the former Soviet Union their age is extended slightly longer, as they are represented in both the Upper Kazanian and the Tatarian stages. Because of the extreme paucity of the current fossil material at hand in China, it is difficult to ascertain with certainty which precise stratigraphic interval these fossils should be assigned. The Pareiasauria and Tapinocephalia in South Africa and the former Soviet Union have a relatively long temporal distribution. Consequently, prior to advanced and detailed future research in China, these fossils can only be assigned with certainty to the Late Permian. A different situation occurs in China's Xinjiang Autonomous Region. In this region, with the exception of dicynodonts, no other fossil vertebrates are discovered. But near the top of the *Lystrosaurus* Beds, minute teeth and bones that may possibly belong to millerettids or eosuchians are found. This situation is extremely close to the condition of the *Daptocephalus* Zone in the Karoo system of South Africa. Therefore, it is believed that the Xinjiang Late Permian fauna belongs to the South African model and may be correlated to the *Daptocephalus* Zone or the lower *Cistecephalus* Zone. Because a single dicynodont has still not appeared in North China at this age, it is not possible to make a reliable

correlation to South Africa and it appears to be relatively closer to the condition in the Soviet Union. It is worth noting that in the Elgin region of Scotland, deposits at the boundary between the top of the Permian and Triassic maintain a condition similar to the upper section of the South African *Daptocephalus* Zone, in addition to the fossil deposits of Xinjiang, where *Striodon* and minute teeth are discovered at the boundary of the Wotongou and Chiutsaiyuantze formations. In Scotland, several dicynodonts are found such as *Gordonia* and *Geikia* as well as the small pareiasaur *Elginia*. However, *Geikia* and *Elginia* are relatively derived and cannot be correlated to the taxa in China. *Gordonia* also appears to be a little too primitive.

V Summary

Current material indicates there are two geographic regions that contain fossil bone in the Permian and Triassic continental deposits of China, these being North China and the Xinjiang Autonomous Region. Each region contains four individual bone bearing stratigraphic units, representing four animal assemblages of different time periods. The conditions of these two localities show both similarities as well as dissimilarities. In conclusion, the stratigraphic position that produces the Middle Triassic *Kannemeyeria* Fauna in Xinjiang is the Kelamayi Fm. and may be correlated to the entire upper section of the Ermaying Fm. of North China. The Early Triassic stratigraphic units consist of the Shaofangou Fm. in Xinjiang and the Liujiagou Fm. in North China, and are both currently unfossiliferous. Therefore it is not possible to conduct an accurate correlation. However, in the Late Permian Period, these two regions clearly differed, with the Xinjiang deposits belonging to the characteristic Gondwana dicynodont complex while the North China deposits appear relatively close to the northern continent's pareiasaur complex.

Translators addendum: see Xiong, Ji and Coney, P.J., l985; Accreted Terranes of China pp.349 361, in Tectonostratigraphic Terranes of the Circum Pacific Region, D.G.Howell ed., for a recent synopsis on micro plate Fm. of China that may relate to the reason for the discrepancies between the North China and Xinjiang faunas.

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Table II Stratigraphic correlation chart.

	Xinjiang	North China	South Africa	Former Soviet Union	India
Upper Triassic	Huang-shan-Chieh (Huangshanjie)			VII	
Middle Triassic	Ke-La-Ma-Yi (Kelamai)	Er-Ma-Ying (Ermaying)	*Cynognathus* Zone	Dongus II VI Dongus I	Yerrapalli
Lower Triassic	Shao-Fang-kou (Shaofanggou) Chiu-Tsai-Yuan-Tze (Jiucaiyuanzi)	Ho-Shan-Kou (Heshangou) Liu-Jia-Kou (Liujiagou)	*Lystrosaurus* Zone	V Wetluga	Panchet
Upper Permian	Wu-Tung-Kou (Wutonggou) Chuan-Tze-Chieh (Quanzijie)	Shih-Chien-Feng (Shiqianfeng) Shih-Ho-Tze (Shihezi)	*Daptocephalus* Zone *Cistecephalus* Zone	IV III	Bijori